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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Luncheon Address
by
James E. Webb, Administrator
National Aeronautics and Space Administration
at the
Annual Meeting of the Institute of Environmental Sciences
Chicago, Illinois
April 12, 1962

* * *

I am sure that you as a group of environmental scientists have a grasp of the broad outlook of the National Space Program and of the relation to this of your own particular branch of science.

Man, through developing a capacity to carry with him an environment within which he can live and work, has conquered, and can perform useful work in the extreme conditions of the earth. In his relatively brief career on earth, man has established livable outposts in the polar regions of the Arctic and Antarctic, has plumbed the depths of the seas, has gone to the fringes of the atmosphere, and recently has successfully launched himself into the even more hostile environment of space.

Man's unique qualities of inquisitiveness, inventiveness, drive to explore the unknown, and urge to make practical use of new opportunities have made the Space Age inevitable. In essence, the success of our effort in manned exploration of the new medium of space depends upon our ability to carry the essential elements of a workable human environment, tightly sealed in spacecraft, to far-distant reaches of the solar system just as we have carried the means to live and thrive to the remotest ends of the earth.

Environmental problems in both the manned and unmanned programs of the National Aeronautics and Space Administration range from those under normal earth atmospheric pressures to those in the "hard" near-vacuum of space; from normal terrestrial surface temperatures to the extreme cold of space and fiery heat of atmospheric re-entry at 18,000 miles per hour from earth orbits or, from a moon voyage, at the fantastic speed of 25,000 miles per hour.

In addition, environmental scientists have to build into manned spacecraft systems means to protect the astronauts against the stresses of very high acceleration at launching and provisions to allow them to function usefully under conditions of weightlessness. Shielding of various types must be furnished against the potentially deadly energetic particles in the Van Allen Radiation Belt surrounding the earth and against the sudden outbursts of radiation that sweep through the solar system when the sun flares into cycles of intense activity.

In the area of the biological sciences, enclosed systems must be developed that will allow man to go from the environment of the earth where he evolved to the utterly alien and airless environment of the moon. They must permit him to work there for varying lengths of time, from hours to days. Beyond the moon, these systems must make it possible for man ultimately to explore the unknown environments of the planets Mars and Venus.

The National Space Program, which has as its focal point the landing of a team of American explorers on the moon during the present decade, needs the creative thoughts, skills, techniques, and participation of your best specialists in the environmental sciences.

Briefly, I would like to sketch for you several examples of the work NASA is doing in the environmental field of the space sciences.

In our space and planetary simulation studies, we are trying to produce likely planetary environments here on earth, to find what life forms familiar to us will grow under such conditions.

The vacuum of space and the atmospheres of the various planets, so far as we can deduce, can be created in appropriately designed chambers on earth. The temperatures and the nature of the light may be simulated as well. Because of the heavy particles in cosmic rays, the space radiation spectrum can be fully studied only in space itself.

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Our Division of Space Biology in the Office of Space Sciences has the specific objectives of searching for extraterrestrial life and studying the effects of strange environments on living organisms, particularly those which we believe may exist in space, on the moon, and on the planets.

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An interesting observation is that the size of these bodies is determined to some extent by the amount of gravity acting during the synthesis periods. In other words, the bacteria-like sphere would be large if formed on Jupiter and small if formed on Mars.

An experiment to check this under zero "g" conditions was included in the Bios flight launched last November. This experiment failed but it will be repeated.

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One of the most interesting experiments is what we call the "sticky string," a small dome-like device to be landed on Mars in 1964 or 1966. When it lands, it will shoot out two adhesive-coated strings, about 100 feet long, which will be wound back into a nutrient solution containing radioactive carbon. If microbes such as we know on earth are captured, they will begin to multiply in the nutrient solution, and radioactive carbon dioxide will be produced. This gas will activate a counter and transmit radio signals that will reach earth monitoring stations.

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I am told that difficulties multiply when you try to devise a five or ten pound package that will survive a landing on Mars, will perform a series of functions without further direction, and will report its findings in intelligible form over many millions of miles.

Until a manned landing on the planets is possible, we will continue our search for extraterrestrial life in many ways. One of the most promising methods is use of newly developed instruments carried aloft by a high-altitude balloon for spectroscopic examination of Mars.

We have such a balloon flight scheduled for early next year which should give us much better observations than any obtained so far concerning an indicated accumulation of hydrocarbon material in the dark areas of Mars.

This balloon flight should also tell us much more about the planetary atmospheres and surfaces, and the presence of such basic elements of life as water vapor, methane, ammonia, and carbon dioxide.

A large payload of experiments is being prepared to determine the effect of zero "g" on a variety of biological processes, including cell division, fertilization, plant growth, photosynthesis, capillarity, fluid transport, convection, diffusion, protoplasmic streaming, and geotropism.

For the first time in millions of years, these phenomena will be operating, or will try to operate, in the absence of gravity.

It is here that we may possibly learn substantially new things about the nature of living processes.

Furthermore, the acquired data may be pertinent to manned space flight.

The NASA space program covers four major categories -- advancement of science, development of practical applications, manned space flight, and aeronautical and space technology. There is not time today to discuss all these areas in detail, but I do want to talk about the manned space flight program leading to the national goal of manned exploration of the moon.

Let me give you a brief summary of what we are doing and planning.

There is still much to learn from Project Mercury, and NASA has manned orbital flights scheduled every 60 to 90 days well into 1963.

We are modifying the Mercury spacecraft -- increasing its battery power and improving its life-support facilities so that later this year or early in 1963 we can go for about a full 24-hour day.

In the summer of 1963, we plan to move into Phase Two of our manned space flight program with Project Gemini. The Gemini spacecraft will show a family resemblance to the familiar Mercury craft ridden by Shepard, Grissom, and Glenn, but will be two or three times as heavy and will have room for two astronauts sitting side by side.

The Gemini will be equipped to remain in orbit for a week or more to test thoroughly the reactions of the astronauts to prolonged weightlessness.

Gemini's other important mission will be to demonstrate the techniques of space rendezvous and the coupling of the spacecraft and an Agena rocket while both are in orbit.

Assume for a moment that the Agena has just been inserted into its appropriate orbit for the rendezvous and docking operation and then, if you will, envisage the optimum launch window for the launch of the Gemini spacecraft, the other vehicle in this experiment. Those of you who followed Friendship 7 during its 5 miles per second orbits about the earth realize that a spacecraft is over a given region for short periods of time. I think you will agree as a consequence that if a rendezvous operation is to be accomplished, it is mandatory that the systems involved perform in the manner intended when called upon.

Successful rendezvous appears possible. It will be a great boon to manned space travel if we can accomplish this feat. Quick mastery of rendezvous and coupling techniques could advance our schedule for landing men on the moon by at least two years. It could also give us the technology on which to base a capability for space rescues, or to rotate crewmen and scientists working in orbiting space laboratories, to bring up supplies, to assemble large space stations, and to perform maintenance work on satellites -- or, as you might say -- set up "service stations" in space. Orbital rendezvous, offering as it does a basis for developing all these possibilities is understandably an attractive approach to lunar flight.

After Gemini, of course, comes Apollo, the three-man spacecraft which we expect to send to the moon and back, after we have tested it on several earth orbits, including a two-week mission and a trip around the moon.

NASA has awarded contracts for design and development of two of the three major Apollo units, or "modules." The first of these is the command center, where the three-man crew will sit side by side. The second is the service unit, containing fuel, electric power supplies, and the propulsion units for take-off from the moon. The third module will contain the retrorockets required for a soft landing on the moon.

The first stage of the Saturn C-1, which had a successful initial flight test last October, is the most powerful rocket known to exist in the world today. It will develop more than four times the 360,000-pound thrust of the Atlas D which boosted John Glenn into orbit, and will place the three-man Apollo in earth orbit.

Late last year, we began developing the Advanced Saturn, whose first stage will have five times the thrust of the

Saturn C-1, and 20 times the thrust of the Atlas D. Perhaps the size of such launch vehicles may be taken as an index of the cost and complexity of the development. The Advanced Saturn will stand about 275 feet tall, about the height of a 27-story building and, as you know, will be assembled as a three-stage vehicle, each stage being developed by a prime contractor. Atop these three stages will be our Apollo spacecraft; to say the least, an engineering challenge with a built-in demand for reliability.

The design of Nova, an even larger rocket, is to be started this year. As we conceive it now, the first stage of Nova will produce 33 times the thrust of Atlas -- 12 million pounds. It will be able to boost into orbit a payload that weighs 130 times more than the Mercury spacecraft and have the power to land man on the moon if this has not already been done with the Advanced Saturn and the rendezvous techniques. In appraising the magnitude of this endeavor in booster development, it is necessary to keep in mind that three completely new engines must be developed for Advanced Saturn and Nova.

As we survey this broad and varied field, the conclusion is inescapable that for the years immediately ahead we have set ourselves tasks in space worthy of a great Nation.

How will we carry them out? That goes centrally to the problem of reliability. I know that this audience is quite familiar with reliability as a professional problem. Reliability in our space program is a matter of major national concern.

This is as good a moment as any to underscore one point John Glenn wisely made in testimony before a Congressional Committee. He said that the Nation must be prepared for failures and sacrifices in future manned space flights. He said that he did not envision every manned flight coming back as successfully as the three we have had so far. And he added: "I hope we will always have the confidence in the program that we now have despite the fact that there will be times when we are not riding a crest of happiness and enthusiasm as we are now."

I think that the people of this country listened very soberly to these words from a man who only a few days before had thought for a moment, as bits of flaming debris flew past his window, that his spacecraft was disintegrating.

There is risk in our manned space program. However, it is our intention to conduct it so that we maximize crew safety and minimize the cost of wasted flights.

Another aspect of the space program which poses many problems of interest to you is the widely varying and severe environments in which instruments and equipment must operate. This is the continuous problem of reliability. Here, expert knowledge of specialists in the environmental sciences can contribute to the fulfillment of our reliability requirements.

At the same time, progress in the space program may contribute to the development of the environmental sciences. For example, in the Mercury spacecraft, we must maintain an environment of pure oxygen at a pressure of 5.1 pounds per square inch -- a little over a third of normal sea level pressure. The same atmospheric conditions will hold in the Gemini spacecraft. For insurance against the possibility of a sudden loss of oxygen in the capsule, the Mercury and Gemini astronauts remain in their space suits throughout their flights and separate oxygen supplies are provided for the suits.

As we proceed step-by-step to gain experience and skill with the flight capability of spacecraft and boosters, and learn how to improve our launching and recovery systems, we will also drive ahead to develop, through aerospace medicine, the know-how that will continue to make more effective utilization of men in space and give them ever greater protection from its hazards.

In the Apollo spacecraft, however, we plan to provide an atmosphere nearer normal, at a pressure half that of sea level. It will have two-fifths oxygen and three-fifths nitrogen. We want to create a shirt-sleeve environment for the Apollo spacecraft, in which it will be safe for the crewmen to leave their space suits during the long journey.

To summarize, following the current series of three-orbit Mercury missions, there will be flights of up to 24 hours with a modified Mercury spacecraft. The Gemini flights may last as long as a week. The Apollo will have a life of two weeks or more. The equipment will have to be so reliable that we can count on it to operate properly over these extended periods of time.

The design of some of the unmanned spacecraft we plan poses even greater challenges. A journey to Venus may require almost five months. To Mars, the travel time can be more than eight months. Then the sensing equipment must operate for sufficient time on arrival. The difficulty inherent in getting equipment to operate unattended for such long periods is obvious.

We now know that integration of a human pilot into spacecraft systems greatly improves reliability. John Glenn's orbital flight on February 20 provided striking evidence when his automatic attitude control system did not function properly and he maintained orientation manually during the last two orbits. If an astronaut had not been aboard, we might well have lost the spacecraft.

We have had a wealth of similar experience in flying the X-15 research aircraft, which has been probing to the fringes of space and has achieved a speed of more than 4,000 miles per hour. In a large portion of the X-15 missions to date, the flights would not have succeeded completely if there had not been a pilot in the cockpit to control and adjust equipment, instruments, or powerplant.

The space program, which I have outlined in part, is a substantial one. It will make demands, not only upon the funds available to the Government but on the Nation's supply of trained specialists. As the space program grows, these demands will increase. If we are to accomplish our goals within the time scales demanded by our national interests, our country needs greatly increased numbers of graduates in science and engineering. The commodity in most critically short supply is brainpower.

NASA is taking steps to help deal with this shortage. It is a pleasure to announce that we shall begin support of a training program at 10 universities next fall in an effort to increase the supply of scientists and engineers to meet the needs of the national space effort.

Each of the 10 universities, representing all parts of the country, will, as an experiment, train 10 predoctoralstudents in the first year. We expect that this program will prove so valuable that we will want to increase it considerably in the years to come.

The 10 universities are selecting candidates for the training grants on the basis of the promise they show of being able to complete their work for the doctorate within three years, the normal duration of the program. The grants will be given for one year at a time, however, and will be renewable so long as the students maintain a quality of work satisfactory to the university.

The students chosen will receive stipends of $2,400 a year for 12 months' study, and expense allowances up to $1,000 a year according to the practice of individual universities. The universities will be reimbursed for tuition, fees, and other expenses involved in the program. The cost for the first group of trainees will be about $2 million.

The universities will judge candidates on the basis of their academic records, personal qualifications, and plans of research and study. The trainees will be citizens of the United States in all but exceptional cases approved by NASA. The following universities have been selected for participation in the first year of the program:

Rensselaer Polytechnic Institute, Troy, New York
University of Maryland, College Park, Maryland
Georgia Institute of Technology, Atlanta, Georgia
University of Michigan, Ann Arbor, Michigan
University of Chicago, Chicago, Illinois
University of Minnesota, Minneapolis, Minnesota
State University of Iowa, Iowa City, Iowa
Texas A. & M. College, College Station, Texas
Rice University, Houston, Texas
University of California, Los Angeles, California

All the great scientific discoveries, on which our civilization has been founded, arose from man's basic drive to learn more about the universe in which we live. In our seeking for knowledge, no real distinction can be made between "space science" and any other kind of science. Everything we learn about the universe -- about the sun which is the source of energy, about the earth on which we make our home and find our material resources, about the origins of life itself -- all this information which we hope to find in space adds to the whole fabric of our knowledge.

There is only one satisfactory way that we can learn about the universe, by traveling in it and taking note of what we find. We are doing just that. I am convinced that the rewards will be tremendous.

I would like to sketch for you the backdrop against which the Space Age has its key significance.

Beginning with balloons, and continuing through the 45 years from the flight of the Wright brothers to the availability of modern jet aircraft, man has constantly improved his machines to overcome the pull of gravity and to transport devices farther and farther from the earth to make scientific measurements. But it was only with the advent of the modern rocket, which does not require the oxygen of the air to combine with its fuel to develop its power, nor the medium of the air as a working fluid, that man could transport measuring devices out beyond the blanket of the earth's atmosphere. This meant that the period when man was confined to making observations of phenomena in space through the distortions of the earth's atmosphere ended, and instruments to measure a wide variety of phenomena could be used out in space and return this information to earth.

To you, as men of science, it is interesting to note that in this case the technologyrequired to make and fly powerful rockets, involving the most efficient use of energy, new lightweight materials, and very complex systems of electronics, had to precede the scientific work which these rockets made possible. It is an interesting fact that a very large part of the work of the National Aeronautics and Space Administration is devoted to the technology of the rocket and, therefore, a large proportion of the cost of the Nation's space program goes to build, launch, keep track of, and use the modern rocket.

In space, advanced rocketry has supplied for the first time in history the ability to investigate otherwise unapproachable natural phenomena and to work with natural forces hitherto unavailable to direct measurement.

We all know that the first 60 years of this century have been years of revolutionary change. Empires have fallen. Upheaval has shaken such vast regions of the world as Russia, China, the Middle East. New nations are emerging in the less developed regions. Communist dictatorships have arisen to challenge constitutional democracy and the right of peoples to self-government or national self-determination.

Paralleling the political upheavals, there has been an all-pervading scientific and technological revolution. Most of the technology basic to teleradio communications developed during this century. So did the growth of the automobile industry, of aviation, and the applications of nuclear energy. In the same period came the development of the modern rocket with the characteristics and potentialities I have already mentioned, but with still another of great significance: with increases in size, even to giant proportions, efficiency in space increases at a very rapid rate. So also do the problems on earth of fabrication, handling, transporting, and launching.

Increasingly, as the scientific and technological revolution gained momentum, the Government has found it necessary to engage in large-scale activities of scientific research and development. We began this in World War II, with the Manhattan District atomic energy project carried out by our military services. But after the war, and responsive to the outcome of a great national debate, Congress passed an Act that placed atomic energy development under a civilian agency. Military requirements were to be satisfied, but the Act specified that efforts which would not violate security should be applied through the Commission for the general welfare.

A few years later, in the broader fields of all the sciences, the 1950 Act creating the National Science Foundation established the goal of stimulating science for the general welfare.

In the 1950's, as rocket development progressed and gave promise of opening the Space Age, we passed another milestone. In 1958, Congress decided to create a new civilian agency of Government, which would have thorough scientific and technological competence in the aeronautical and space fields.

Again, Congress acted to provide that this new area of science and technology would be used for the general welfare.

The new agency, which I have the honor to head, the National Aeronautics and Space Administration, was built around the National Advisory Committee for Aeronautics, the Jet Propulsion Laboratory of the California Institute of Technology, elements of the Naval Research Laboratory, and the Army's von Braun group at Huntsville, Alabama.

The law requires of NASA a long-range plan, and this was established under the previous Administration. That plan laid out a progression of space research and exploration events toward which to work over a period of 15 years.

Last year, when faced with ever more rapid Soviet progress in space, and with new opportunities opening up from our own progress in science and technology, President Kennedy reviewed this long-range plan. He determined with the help and advice of Vice President Johnson and the National Aeronautics and Space Council, that it is feasible to compress the 15 years of effort called for under the old plan into a decade under a new plan. The President proposed, and Congress endorsed a program to accomplish this accelerated schedule.

It is the importance and scope of this most important decision, participated in by the President and the Congress, that justifies your interest and your support. I appreciate this opportunity to give you the policies involved and the programs based thereon.

Thank you very much.

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MAN MUST TAKE ENVIRONMENT INTO SPACE*

by

JAMES E. WEBB
ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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*Based on remarks at the Annual Meeting of the Institute of Environmental Sciences, Chicago, Ill.

JAMES E. WEBB
ADMINISTRATOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

President Kennedy appointed James Edwin Webb Administrator of the National Aeronautics and Space Administration on February 14, 1961.

Mr. Webb is a member of the Federal Council for Science and Technology, the President's Committee on Equal Opportunity, and the National Aeronautics and Space Council, and is Chairman of the Distinguished Civilian Service Awards Board.

An attorney and businessman, Mr. Webb has served in high governmental and industry positions. He has been active in aviation and education. He is a former Director of the Bureau of the Budget and a former Under Secretary of State. He has been a vice president of the Sperry Gyroscope Co., New York City, chairman of the board of directors of the Republic Supply Co. and a director of Kerr-McGee Oil Industries, Inc.—both with headquarters in Oklahoma City, Okla.—and a director of the McDonnell Aircraft Co., St. Louis, Mo.

In private life, Mr. Webb was a member of a number of Government advisory boards, including the President's Committee to Study the U.S. Military Assistance Program—popularly known as the "Draper Committee." He has been engaged in many public service programs related to his long-term interest in science.

Born October 7, 1906, in Granville County, N.C., Mr. Webb graduated in 1928 from the University of North Carolina with a bachelor's degree in education. Later, he studied law at George Washington University, Washington, D.C., and was admitted to the District of Columbia bar in 1936.

In the early 1930's, Mr. Webb became a U.S. Marine Corps Reserve officer and pilot, and he currently holds a commission as a lieutenant colonel in the Marine Corps Reserve.

In 1936, he joined Sperry Gyroscope, serving during 7 years as personnel director, assistant to the president, secretary and treasurer, and vice president.

Mr. Webb became an assistant to the Under Secretary of the Treasury in 1946. Later that year, President Truman appointed him Director of the Bureau of the Budget, a position he held for 3 years. From 1949 to 1952, Mr. Webb served as Under Secretary of State in the Truman administration. From 1953 to 1958, Mr. Webb served as president of the Republic Supply Co. and became chairman of the board in 1958. Between 1952 and 1959, he engaged in a number of business activities, including aircraft manufacturing and accessories, oil equipment and supplies, banking and law.

In 1959, Mr. Webb reduced his activity in business and returned to Washington, where he again devoted much of his time to public service.

Mr. Webb has been awarded the following honorary degrees: LL.D., University of North Carolina, 1949; Syracuse University, 1950; Colorado College, 1957; and George Washington University, June 1961. Sc. D., Notre Dame University, June 1961, and Washington University, St. Louis, February 1962.

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Project Mercury Astronaut Donald K. Slayton checks his instrument panel prior to a training flight on the human centrifuge at the Aviation Medical Acceleration Laboratory at Johnsville, Pa.

Space, a "Hard" Near-Vacuum

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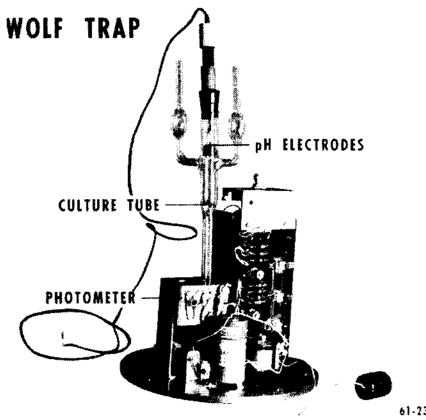
WOLF TRAP



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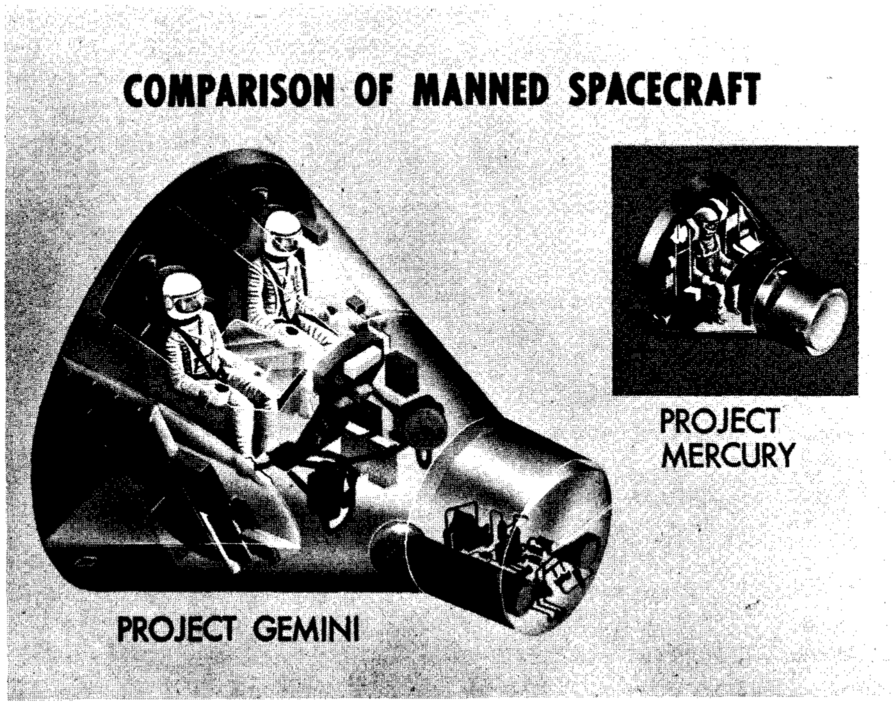
I am told that difficulties multiply when you try to devise a 5- or 10-pound package that will survive a landing on Mars, will perform a series of functions without further direction, and will report its findings in intelligible form over many millions of miles.

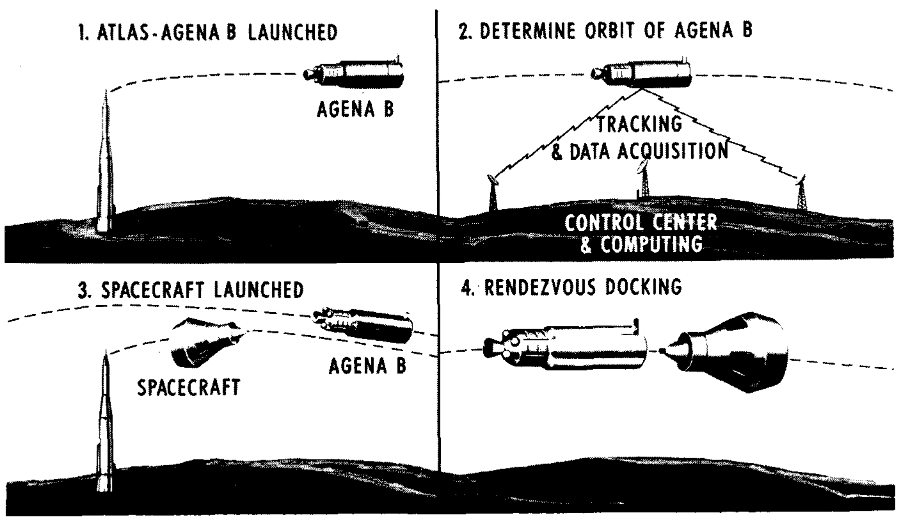
Until a manned landing on the planets is possible, we will continue our search for extraterrestrial life in many ways. One of the most promising methods is use of newly developed in-



Project Gemini's two-man spacecraft (left) will have 50 percent greater volume and weigh two to three times as much, as the one-man Project Mercury spacecraft (right).

A major assignment for Project Gemini is to demonstrate and develop techniques of rendezvous in space. This operation will be basic to future stages of manned space exploration.

PROJECT GEMINI
FLIGHT MISSION



struments carried aloft by a high-altitude balloon for spectroscopic examination of Mars.

We have such a balloon flight scheduled for early next year which should give us much better observations than any obtained so far concerning an indicated accumulation of hydrocarbon material in the dark areas of Mars.

This balloon flight should also tell us much more about the planetary atmospheres and surfaces, and the presence of such basic elements of life as water vapor, methane, ammonia, and carbon dioxide.

A large payload of experiments is being prepared to determine the effect of zero "g" on a variety of biological processes, including cell division, fertilization, plant growth, photosynthesis, capillarity, fluid transport, convection, diffusion, protoplasmic streaming, and geotropism.

For the first time in millions of years, these phenomena will be operating, or will try to operate, in the absence of gravity.

It is here that we may possibly learn substantially new things about the nature of living processes.

Furthermore, the acquired data may be pertinent to manned space flight.

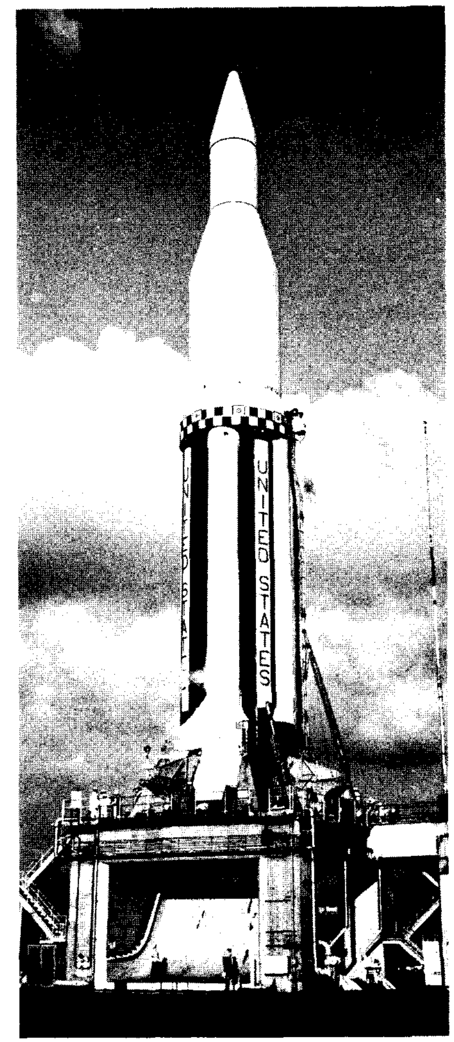
Manned Exploration of the Moon

The NASA space program covers four major categories—advancement of science, development of practical applications, manned space flight, and aeronautical and space technology. There is not time today to discuss all these areas in detail, but I do want to talk about the manned space flight program leading to the national goal of manned exploration of the moon.

Let me give you a brief summary of what we are doing and planning.

There is still much to learn from Project Mercury, and NASA has manned orbital flights scheduled every 60 to 90 days well into 1963.

We are modifying the Mercury spacecraft—increasing its battery power and improving its life-support fa-

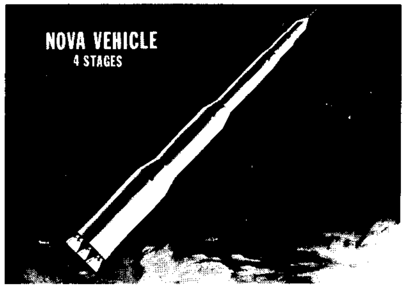


Saturn C–1 on complex 34 at Cape Canaveral. This launch vehicle will develop 1.5 million pounds of thrust, more than four times that of Atlas D, which boosted Astronaut John Glenn into space.

cilities so that we will be able to go for a 24-hour mission.

In the summer of 1963, we plan to move into Phase Two of our manned space flight program with Project Gemini. The Gemini spacecraft will show a family resemblance to the familiar Mercury craft, but will be two or three times as heavy and will have room for two astronauts sitting side by side.

The Gemini will be equipped to remain in orbit for a week or more to



Nova, now a concept, is to provide thrust 33 times that of Atlas—12 million pounds. It will be capable of boosting into orbit a payload weighing 130 times that of the Mercury spacecraft.

test thoroughly the reactions of the astronauts to prolonged weightlessness.

Gemini's other important mission will be to demonstrate the techniques of space rendezvous and the coupling of the spacecraft and an Agena rocket while both are in orbit.

Assume for a moment that the Agena has just been inserted into its appropriate orbit for the rendezvous and docking operation and then, if you will, envisage the optimum launch window for the launch of the Gemini spacecraft, the other vehicle in this experiment. Those of you who followed Friendship 7 during its 5 miles per second orbits about the earth realize that a spacecraft is over a given region for short periods of time. I think you will agree as a consequence that if a rendezvous operation is to be accomplished, it is mandatory that the systems involved perform in the manner intended when called upon.

Successful rendezvous appears possible. It will be a great boon to manned space travel if we can accomplish this feat. Quick mastery of rendezvous and coupling techniques could advance our schedule for landing men on the moon by at least 2 years. It could also give us the technology on which to base a capability for space rescues, or to rotate crewmen and scientists working in orbiting space laboratories, to bring up supplies, to assemble large space stations, and to perform maintenance work on satellites—or, as you might say—set up "service stations" in space. Orbital rendezvous, offering as it does a basis for developing all these possibilities is understandably an attractive approach to lunar flight.

After Gemini, of course, comes Apollo, the three-man spacecraft which we expect to send to the moon and back, after we have tested it on several earth orbits, including a 2-week mission and a trip around the moon.

NASA has awarded contracts for design and development of two of the three major Apollo units, or "modules." The first of these is the command center, where the three-man crew will sit side by side. The second is the service unit, containing fuel, electric power supplies, and the propulsion units for take-off from the moon. The third module will contain the retrorockets required for a soft landing on the moon.

The first stage of the Saturn C–1, which had a successful initial flight test

Astronaut John H. Glenn: "I hope we will always have the confidence in the program that we now have."

last October, is the most powerful rocket known to exist in the world today. It will develop more than four times the 360,000-pound thrust of the Atlas D which boosted John Glenn into orbit, and will place the three-man Apollo in earth orbit.

Late last year, we began developing the Advanced Saturn, whose first stage will have 5 times the thrust of the Saturn C–1, and 20 times the thrust of the Atlas D. Perhaps the size of such launch vehicles may be taken as an index of the cost and complexity of the development. The Advanced Saturn will stand about 275 feet tall, about the height of a 27-story building and, as you know, will be assembled as a three-stage vehicle, each stage being developed by a prime contractor. Atop these three stages will be our Apollo spacecraft; to say the least, an engineering challenge with a built-in demand for reliability.

The design of Nova, an even larger rocket, is to be started this year. As we conceive it now, the first stage of Nova will produce 33 times the thrust of Atlas—12 million pounds. It will be able to boost into orbit a payload that weighs 130 times more than the Mercury spacecraft and have the power to land man on the moon if this has not already been done with the Advanced Saturn and the rendezvous techniques. In appraising the magnitude of this endeavor in booster development, it is necessary to keep in mind that three completely new engines must be developed for Advanced Saturn and Nova.

As we survey this broad and varied field, the conclusion is inescapable that for the years immediately ahead we have set ourselves tasks in space worthy of a great Nation.

How will we carry them out? That goes centrally to the problem of reliability. Reliability in our space program is a matter of major national concern.

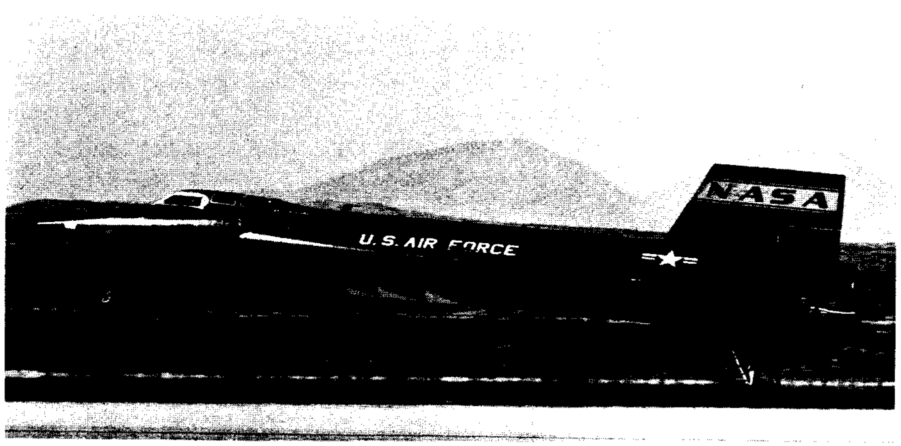
This is as good a moment as any to underscore one point John Glenn wisely made in testimony before a congressional committee. He said that the Nation must be prepared for failures and sacrifices in future manned space flights. He said that he did not envision every manned flight coming back as successfully as the three we had had up to that time. And he added: "I hope we will always have the confidence in the program that we now have despite the fact that there will be times when we are not riding a crest of happiness and enthusiasm as we are now."

I think that the people of this country listened very soberly to these words from a man who only a few days before had thought for a moment, as bits of flaming debris flew past his window, that his spacecraft was disintegrating.

There is risk in our manned space program. However, it is our intention to conduct it so that we maximize crew safety and minimize the cost of wasted flights.

Safeguards for Severe Environments

Another aspect of the space program which poses many problems of interest to you is the widely varying and severe environments in which instruments and equipment must operate. This is the continuous problem of reliability. Here, expert knowledge of specialists in the environmental sciences can contribute to the fulfillment of our reliability requirements.



The X–15 rocket-powered research airplane landing at the Flight Research Center, Edwards, Calif. This aircraft is designed for speeds of 4,000 miles per hour; altitudes of 50 to 100 miles.

At the same time, progress in the space program may contribute to the development of the environmental sciences. For example, in the Mercury spacecraft, we must maintain an environment of pure oxygen at a pressure of 5.1 pounds per square inch—a little over a third of normal sea level pressure. The same atmospheric conditions will hold in the Gemini spacecraft. For insurance against the possibility of a sudden loss of oxygen in the capsule, the Mercury and Gemini astronauts remain in their space suits throughout their flights and separate oxygen supplies are provided for the suits.

As we proceed step-by-step to gain experience and skill with the flight capability of spacecraft and boosters, and learn how to improve our launching and recovery systems, we will also drive ahead to develop, through aerospace medicine, the know-how that will continue to make more effective utilization of men in space and give them ever greater protection from its hazards.

In the Apollo spacecraft, however, we plan to provide an atmosphere nearer normal, at a pressure half that of sea level. It will have two-fifths oxygen and three-fifths nitrogen. We want to create a shirt-sleeve environment for the Apollo spacecraft, in which it will be safe for the crewmen to leave their space suits during the long journey.

To summarize, following the current series of three-orbit Mercury missions, there will be flights of up to 24 hours with a modified Mercury spacecraft. The Gemini flights may last as long as a week. The Apollo will have a life of 2 weeks or more. The equipment will have to be so reliable that we can count on it to operate properly over these extended periods of time.

The design of some of the unmanned spacecraft we plan poses even greater challenges. A journey to Venus may require almost 5 months. To Mars, the travel time can be more than 8 months. Then the sensing equipment must operate for sufficient time on arrival. The difficulty inherent in getting equipment to operate unattended for such long periods is obvious.

We now know that integration of a human pilot into spacecraft systems greatly improves reliability. John Glenn's orbital flight on February 20 provided striking evidence when his automatic attitude control system did not function properly and he maintained orientation manually during the last two orbits. If an astronaut had not been aboard, we might well have lost the spacecraft.

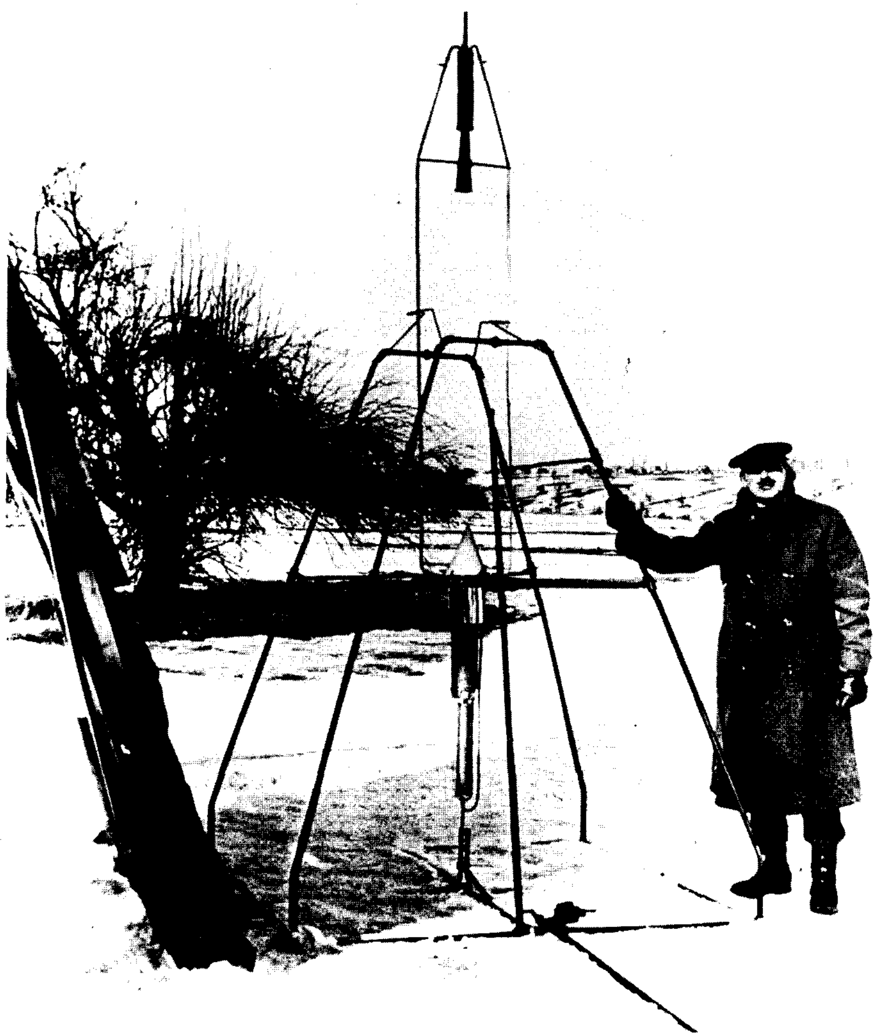
We have had a wealth of similar experience in flying the X–15 research aircraft, which has been probing to the fringes of space and has achieved a speed of more than 4,000 miles per hour. In a large portion of the X–15 missions to date, the flights would not have succeeded completely if there had not been a pilot in the cockpit to control and adjust equipment, instruments, or powerplant.

University Programs for Science Training

The space program, which I have outlined in part, is a substantial one. It will make demands, not only upon the funds available to the Government but on the Nation's supply of trained specialists. As the space program grows, these demands will increase. If we are to accomplish our goals within the time scales demanded by our national interests, our country needs greatly increased numbers of graduates in science and engineering. The commodity in most critically short supply is brainpower.

NASA is taking steps to help deal with this shortage. It is a pleasure to announce that we shall begin support of a training program at 10 universities next fall in an effort to increase the supply of scientists and engineers to meet the needs of the national space effort.

Each of the 10 universities, representing all parts of the country, will as an experiment, train 10 predoctoral students in the first year. We expect

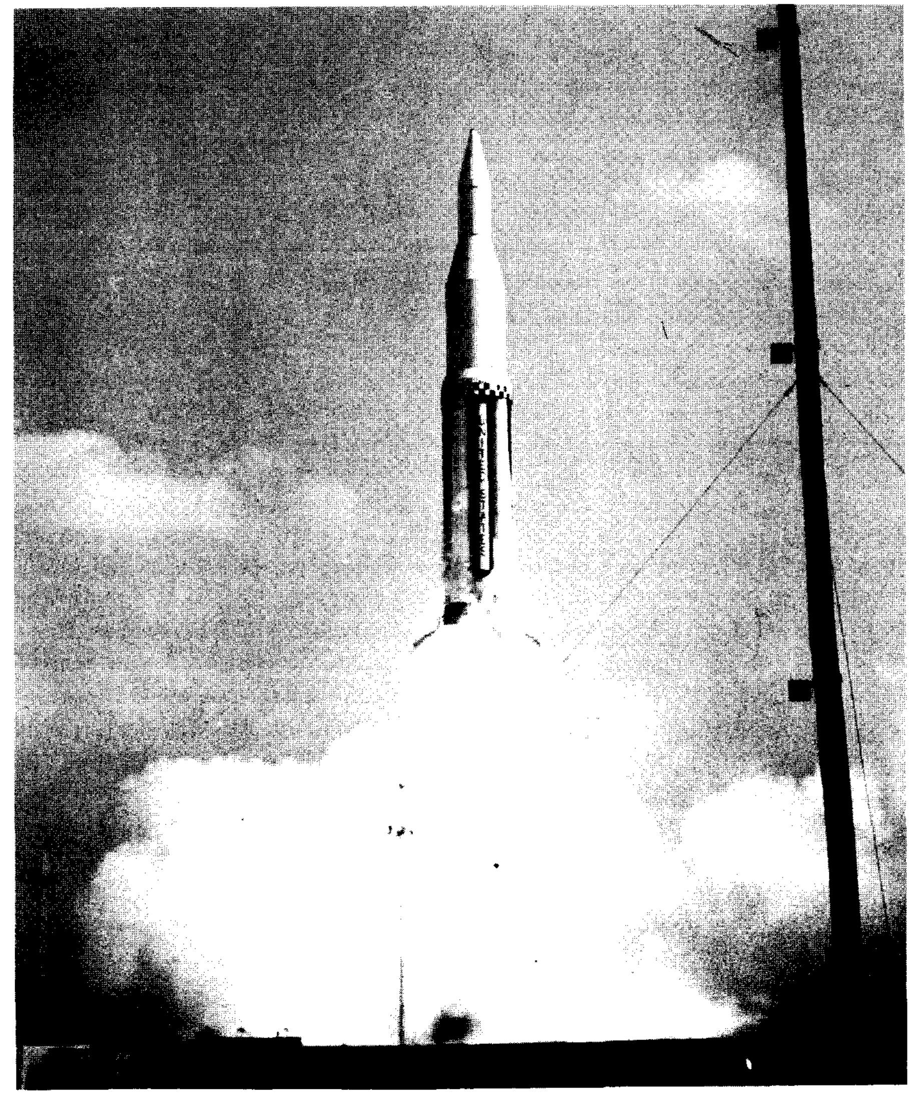


Dr. Robert H. Goddard standing beside the world's first liquid fuel rocket. This liquid oxygen-gasoline rocket was successfully fired on March 16, 1926.

that this program will prove so valuable that we will want to increase it considerably in the years to come.

The 10 universities are selecting candidates for the training grants on the basis of the promise they show of being able to complete their work for the doctorate within 3 years, the normal duration of the program. The grants will be given for 1 year at a time, however, and will be renewable so long as the students maintain a quality of work satisfactory to the university.

The students chosen will receive stipends of $2,400 a year for 12 months' study, and expense allowances up to $1,000 a year according to the practice of individual universities. The uni-



The second Saturn research and development vehicle leaving the pad at Cape Canaveral on April 25, 1962.

versities will be reimbursed for tuition, fees, and other expenses involved in the program. The cost for the first group of trainees will be about $2 million.

The universities will judge candidates on the basis of their academic records, personal qualifications, and plans of research and study. The trainees will be citizens of the United States in all but exceptional cases approved by NASA. The following universities have been selected for participation in the first year of the program:

Rensselaer Polytechnic Institute, Troy, N.Y.

University of Maryland, College Park, Md.

Georgia Institute of Technology, Atlanta, Ga.

University of Michigan, Ann Arbor, Mich.

University of Chicago, Chicago, Ill.

University of Minnesota, Minneapolis, Minn.

State University of Iowa, Iowa City, Iowa

Texas A. & M. College, College Station, Tex.

Rice University, Houston, Tex.

University of California, Los Angeles, Calif.

All the great scientific discoveries, on which our civilization has been founded, arose from man's basic drive to learn more about the universe in which we live. In our seeking for knowledge, no real distinction can be made between "space science" and any other kind of science. Everything we learn about the universe—about the sun which is the source of energy, about the earth on which we make our home and find our material resources, about the origins of life itself—all this information which we hope to find in space adds to the whole fabric of our knowledge.

There is only one satisfactory way that we can learn about the universe, by traveling in it and taking note of what we find. We are doing just that. I am convinced that the rewards will be tremendous.

Background for Space Age Missions

I would like to sketch for you the backdrop against which the Space Age has its key significance.

Beginning with balloons, and continuing through the 45 years from the flight of the Wright brothers to the availability of modern jet aircraft, man has constantly improved his machines to overcome the pull of gravity and to transport devices farther and farther from the earth to make scientific measurements. But it was only with the advent of the modern rocket, which does not require the oxygen of the air to combine with its fuel to develop its power, nor the medium of the air as a working fluid, that man could transport measuring devices out beyond the blanket of the earth's atmosphere. This meant that the period when man was confined to making observations of phenomena in space through the distortions of the earth's atmosphere ended, and instruments to measure a wide variety of phenomena could be used out in space and return this information to earth.

To men of science it is interesting to note that in this case the technology required to make and fly powerful rockets, involving the most efficient use of energy, new lightweight materials, and very complex systems of electronics, had to precede the scientific work which these rockets made possible. It is an interesting fact that a very large part of the work of the National Aeronautics and Space Administration is devoted to the technology of the rocket and, therefore, a large proportion of the cost of the Nation's space program goes to build, launch, keep track of, and use the modern rocket.

In space, advanced rocketry has supplied for the first time in history the ability to investigate otherwise unapproachable natural phenomena and to work with natural forces hitherto unavailable to direct measurement.

We all know that the first 60 years of this century have been years of revolutionary change. Empires have fallen. Upheaval has shaken such vast regions of the world as Russia, China, the Middle East. New nations are emerging in the less developed regions. Communist dictatorships have arisen to challenge constitutional democracy and the right of peoples to self-government or national self-determination.

Paralleling the political upheavals, there has been an all-prevading scientific and technological revolution. Most of the technology basic to teleradio communications developed during this century. So did the growth of the automobile industry, of aviation, and the applications of nuclear energy. In the same period came the development of the modern rocket with the characteristics and potentialities I have already mentioned, but with still another of great significance: with increases in size, even to giant proportions, efficiency in space increases at a very rapid rate. So also do the problems on earth of fabrication, handling, transporting, and launching.

Increasingly, as the scientific and technological revolution gained momentum, the Government has found it necessary to engage in large-scale activities of scientific research and development. We began this in World War II, with the Manhattan District atomic energy project carried out by our military services. But after the war, and responsive to the outcome of a great national debate, Congress passed an act that placed atomic energy development under a civilian agency. Military requirements were to be satisfied, but the act specified that efforts which would not violate security should be applied through the Commission for the general welfare.

A few years later, in the broader fields of all the sciences, the 1950 act creating the National Science Foundation established the goal of stimulating science for the general welfare.

Organization of NASA

In the 1950's, as rocket development progressed and gave promise of opening the Space Age, we passed another milestone. In 1958, Congress decided to create a new civilian agency of Government, which would have thorough scientific and technological competence in the aeronautical and space fields. Again, Congress acted to provide that this new area of science and technology would be used for the general welfare.

The new agency, which I have the honor to head, the National Aeronautics and Space Administration, was built around the National Advisory Committee for Aeronautics, the Jet Propulsion Laboratory of the California Institute of Technology, elements of the Naval Research Laboratory, and the Army's von Braun group at Huntsville, Ala.

The law requires of NASA a long-range plan, and this was established under the previous administration. That plan laid out a progression of space research and exploration events toward which to work over a period of 15 years.

Last year, when faced with ever more rapid Soviet progress in space, and with new opportunities opening up from our own progress in science and technology, President Kennedy reviewed this long-range plan. He determined with the help and advice of Vice President Johnson and the National Aeronautics and Space Council, that it is feasible to compress the 15 years of effort called for under the old plan into a decade under a new plan. The President proposed, and Congress endorsed a program to accomplish this accelerated schedule.

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

U.S. GOVERNMENT PRINTING OFFICE: 1962 O—643495

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. – Price 10 cents